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Medication errors: prescribing faults and prescription errors

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1. Medication errors are common in general practice and in hospitals. Both errors in the act of writing (prescription errors) and prescribing faults due to erroneous medical decisions can result in harm to patients.
2. Any step in the prescribing process can generate errors. Slips, lapses, or mistakes are sources of errors, as in unintended omissions in the transcription of drugs. Faults in dose selection, omitted transcription, and poor handwriting are common.
3. Inadequate knowledge or competence and incomplete information about clinical characteristics and previous treatment of individual patients can result in prescribing faults, including the use of potentially inappropriate medications.
4. An unsafe working environment, complex or undefined procedures, and inadequate communication among health-care personnel, particularly between doctors and nurses, have been identified as important underlying factors that contribute to prescription errors and prescribing faults.
5. Active interventions aimed at reducing prescription errors and prescribing faults are strongly recommended. These should be focused on the education and training of prescribers and the use of on-line aids. The complexity of the prescribing procedure should be reduced by introducing automated systems or uniform prescribing charts, in order to avoid transcription and omission errors. Feedback control systems and immediate review of prescriptions, which can be performed with the assistance of a hospital pharmacist, are also helpful. Audits should be performed periodically.

Prescribing faults and prescription errors are major problems among medication errors. They occur both in general practice and in hospital, and although they are rarely fatal they can affect patients' safety and quality of healthcare. A definition states that a 'clinically meaningful prescribing error occurs when . . . there is an unintentional significant reduction in the probability of treatment being timely and effective or increase in the risk of harm when compared with generally accepted practice' [1]. This definition is clearly oriented to the outcome of the error. However, it does not take into account failures that can occur during the whole process of prescribing, independently of any potential or actual harm [2]. Prescription errors encompass those related to the act of writing a prescription, whereas prescribing faults encompass irrational prescribing, inappropriate prescribing, underprescribing, overprescribing, and ineffective prescribing, arising from erroneous medical judgement or decisions concerning treatment or treatment monitoring [3, 4]. Appropriate prescribing results when errors are minimized and when the prescriber actively endeavours to achieve better prescribing: both actions are required.

Prevalence

The prevalence of prescribing faults and prescription errors has been quantified in prospective and retrospective cohort studies. Internal or external reviews of prescriptions, performed mostly by experienced pharmacists, or direct interviews or voluntary reports from prescribers have been used as sources of information [4, 5]. Depending on the reference parameters used, the observed incidence varies greatly. It is usually higher in process-oriented studies, which evaluate the presence in the prescription of potentially harmful errors, than in outcome-oriented studies, which mostly evaluate the incidence of preventable adverse drug effects. Prescription errors account for 70% of medication errors that could potentially result in adverse effects. A mean value of prescribing errors with the potential for adverse effects in patients of about 4 in 1000 prescriptions was recorded in a teaching hospital. Such errors are also frequent in ambulatory settings [4–6]. However, given the inconsistency of the criteria used to identify errors and the various definitions used, it is not surprising that a recent meta-analysis showed that the range of errors attributable to junior doctors, who are

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responsible for most prescriptions in hospitals, can vary from 2 to 514 per 1000 prescriptions and from 4.2 to 82% of patients or charts reviewed [7].

Sources

All procedures related to prescribing are error-generating steps. A prescribing fault can arise from the choice of the wrong drug, the wrong dose, the wrong route of administration, and the wrong frequency or duration of treatment, but also from inappropriate or erroneous prescribing in relation to the characteristics of the individual patient or co-existing treatments; it may also depend on inadequate evaluation of potential harm deriving from a given treatment [3, 8]. Errors in dose selection occur most commonly, and represent >50% of all prescribing faults.

Inaccuracy in writing and poor legibility of handwriting, the use of abbreviations or incomplete writing of a prescription, for example by omitting the total volume of solvent and duration of a drug infusion, can lead to misinterpretation by healthcare personnel. This can result in errors in drug dispensing and administration. Unintended omissions – or failure to withdraw a drug – are also frequent. A critical point is the transcription of previous treatments at the time of admission to hospital, so-called 'medication reconciliation'. Unintended omission or changes in the dosing regimen are frequent, and account for 15–59% of medication errors [9]. Inaccurate medication history taking can cause omission of treatment, resulting in potential harm in more than one-third of patients taking more than four drugs [10]. Transfer of a patient's care within the same institution or between a hospital and a general practitioner also favours prescribing faults due to omission [11].

Why do these errors occur? According to the theories of human error, errors in prescribing, as in any other complex and high-risk procedure, are occasioned by and depend on failure of individuals, but are generated, or at least facilitated, by failures in systems [12]. It might therefore be expected that the larger the number of prescriptions, and the more steps in the prescribing procedure, the higher the risk of error.

Prescription errors are typically events that derive from slips, lapses, or mistakes [2], for example, writing a dose that is orders of magnitude higher or lower than the correct one because of erroneous calculation, or erroneous prescription due to similarities in drug brand names or pharmaceutical names [13]. Human factors may therefore be the first identifiable causes of error. However, in most cases, analysis of error-inducing conditions shows an unsafe environment as the 'latent condition' that contributes to the accident. According to Reason's 'Swiss cheese' model of accident causation, sequential failures in the system and insufficient defences and counteractions are required for the event to occur [14]. In the case of prescribing errors, inadequate feedback control or lack of cooperation between doctor and nurses, with undefined roles concerning responsibility in prescribing, generate a cascade of errors that can lead to an adverse effect. Among doctors, stressful conditions, a heavy workload, a difficult work environment, insufficient communication within the team, and not being in good physical and mental condition are among the primary causes of prescribing faults and prescription errors [8].

Inappropriate prescribing most often derives from a wrong medical decision, because of lack of knowledge or inadequate training. Junior doctors often work in stressful circumstances that are perceived as routine by experienced doctors. Errors are more frequently made by junior members of staff and inadequate knowledge or training often underlie inappropriate prescribing and other faults [3, 8]. Inadequate staffing, lack of skills and knowledge of relevant rules, tasks outside the routine, or taking care of another doctor's patient have also been identified as conditions associated with prescribing faults [8].

Adverse outcomes can be related to lack of knowledge or skill. Even the apparently simple act of transcribing previous medications and collecting information as part of the medication history requires a knowledge of pharmacotherapy as well as adequate information about the patient's clinical condition. Equally, the choice of dose requires information about the patient's clinical status and immediate verification of the appropriateness of treatment.

Factors related to patients can also result in errors, leading to adverse effects, since these are associated in most cases with identifiable clinical conditions, such as reduced renal and hepatic function or a history of allergy requiring atypical or unusual dosage and frequency [3, 15]. Polypharmacy and management of elderly patients or children are associated with inappropriate or potentially inappropriate prescribing and errors [15]. Monitoring of drug action is necessarily part of the prescribing process, to allow optimization or adjustments of doses or treatments. In ambulatory care, prescribing faults are mostly related to the use of inappropriate doses and inadequate monitoring [16].

Prevention

Acquisition of information through error-reporting systems is a prerequisite for preventing prescribing faults and prescription errors, as is the adoption of shared criteria for the appropriateness of procedures. Error-reporting systems, both internal and external to healthcare institutions, have been widely used [14, 17–19]. Reporting is usually voluntary and confidential, but must be timely and evaluated by experts, in order to identify critical conditions and allow systems analysis. Prescribers should be informed and become aware of errors that have been made in their environment and of the conclusions of the analysis.

Spontaneous reporting is about 10 times less effective in detecting errors and potential adverse effects than active interventions, such as chart review and patient monitoring [20]. Active, systems-oriented interventions aimed at improving processes, rather than individual performance, should therefore be advocated [14, 21]. Three major intervention strategies can be adopted:

- reduction of complexity in the act of prescribing by the introduction of automation;
- improved prescribers' knowledge by education and the use of on-line aids;
- feedback control systems and monitoring of the effects of interventions [22].

Computerized systems

The use of automated prescribing systems is recommended as an effective tool to reduce medication errors. They can reduce the risk of harm that arises from prescribing faults and improve the quality of medical care by reducing errors in drug dispensing and administration. Computerized advice can give significant benefits by guiding the prescription of optimal dosages. This should translate into reduced time to therapeutic stabilization, reduced risks of adverse effects, and eventually reduced lengths of hospital stay [23].

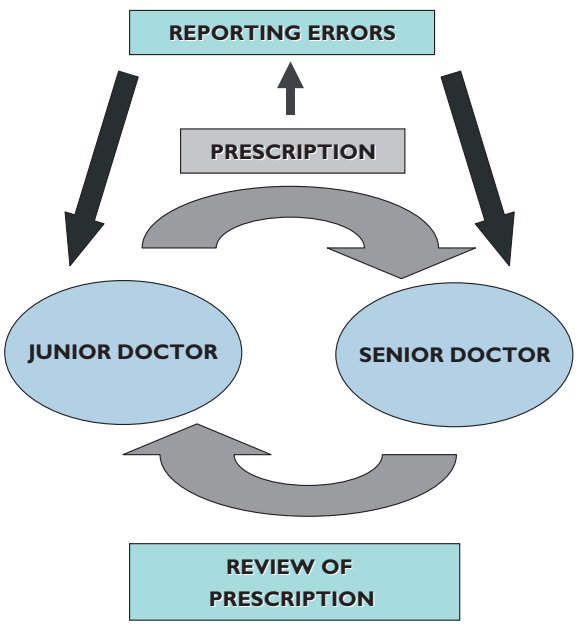
Prescription charts

Nevertheless, electronic systems are not yet widely available, are expensive, and require training. Comprehensive interventions aimed at improving patient safety using a systematic approach are progressing in different institutions, with the use of uniform medication charts, on which all the relevant clinical information is shown along with the prescriptions, so that transcription is abolished. This approach has been validated as a relatively simple alternative to electronic drug prescribing and dispensing systems [24]. Furthermore, the use of electronic systems in addition to a single uniform medication chart forces staff to develop interdisciplinary collaboration and procedures that allow immediate feedback control both among prescribers and between prescribers and other staff (e.g. non-prescribing nurses) (Figure 1).

The input of a hospital pharmacist has been regarded as a major contribution to the identification and reduction of error and is therefore recommended if it can be afforded. Frequent review of prescriptions with the aid of a pharmacist reduces adverse effects, as recent reviews of the literature have shown [25, 26].

Education and systems approaches

Education of medical students and junior doctors is highly advisable [27, 28]. Training and feedback control of



Prescription

The five 'rights':
- Patient
- Drug
- Dose
- Route
- Timing (frequency and duration)

Use on-line aids to prescription and automated medication systems or uniform medication charts

Review of prescription

Monitor clinical benefits and harms from treatment:
- Beneficial effects
- Adverse drug reactions
- Drug-drug interactions

Monitor plasma concentrations or biomarkers to evaluate adherence, benefits, and harms

Figure 1
A diagram of active interventions aimed at reducing adverse drug-related events

prescribing by tutors and senior doctors should be associated with availability of on-line references for immediate identification and verification of potential prescribing faults [29]. The choice of treatment should generally be in line with approved guidelines, although flexibility may be necessary in individual cases.

Constraints can minimize omissions, for example the introduction of check lists or strict rules in writing a prescription, and the use of well-structured medication charts, as mentioned above. Handwritten prescriptions should not contain ambiguous abbreviations or symbols. Frequent and immediate review of prescriptions as well as monitoring of potential harms deriving from treatment should be encouraged. Polypharmacy requires special attention. Potentially inappropriate medications should be identified, and drugs with narrow therapeutic ranges or associated with frequent adverse reactions should be avoided if possible and carefully monitored when used.

Careful evaluation of drug–drug interactions and all types of adverse reactions is necessarily part of a programme aimed at improving patient safety and may require monitoring of plasma drug concentrations and evaluation of biomarkers of beneficial or adverse effects. Audit can contribute to appropriate prescribing and error reduction [24].

Conclusion

Errors and faults in prescribing are in most cases preventable. Intervention strategies should be primarily focused on education and the creation of a safe and cooperative working environment, to strengthen defence systems and minimize harm to the patient.

Systems-oriented interventions increase awareness of risk among healthcare personnel [14]. Interventions aimed at improving knowledge and training, and reducing complexity, and the introduction of strict feedback control and monitoring systems are highly advisable. However, large-scale information on the beneficial effects of interventions aimed at reducing harm from prescribing faults and prescription errors is not yet available and is needed.

Competing interests

None to declare.

REFERENCES

1 Dean B, Barber N, Schachter M. What is a prescribing error? Qual Health Care 2000; 9: 232–7.

2 Ferner RE, Aronson JK. Clarification of terminology in medication errors: definitions and classification. Drug Saf 2006; 29: 1011–22.

3 Lesar TS, Briceland L, Stein DS. Factors related to errors in medication prescribing. JAMA 1997; 277: 312–7.

4 Dean B, Vincent C, Schachter M, Barber N. The incidence of prescribing errors in hospital inpatients: an overview of the research methods. Drug Saf 2005; 28: 891–900.

5 Dean B, Schachter M, Vincent C, Barber N. Prescribing errors in hospital inpatients: their incidence and clinical significance. Qual Saf Health Care 2002; 11: 340–4.

6 Kuo GM, Phillips RL, Graham D, Hickner JM. Medication errors reported by US family physicians and their office staff. Qual Saf Health Care 2008; 17: 286–90.

7 Ross S, Bond C, Rothnie H, Thomas S, Macleod MJ. What is the scale of prescribing errors committed by junior doctors? A systematic review. Br J Clin Pharmacol 2009; 67: 629–40.

8 Dean B, Schachter M, Vincent C, Barber N. Causes of prescribing errors in hospital inpatients: a prospective study. Lancet 2002; 359: 1373–8.

9 Cornish PL, Knowles SR, Marchesano R, Tam V, Shadowitz S, Juurlink DN, Etchells EE. Unintended medication discrepancies at the time of hospital admission. Arch Intern Med 2005; 165: 424–9.

10 Tam VC, Knowles SR, Cornish PL, Fine N, Marchesano R, Etchells EE. Frequency, type and clinical importance of medication history errors at admission to hospital: a systematic review. CMAJ 2005; 173: 510–5.

11 Knudsen P, Herborg H, Mortensen AR, Knudsen M, Hellebek A. Preventing medication errors in community pharmacy: root-cause analysis of transcription errors. Qual Saf Health Care 2007; 16: 285–90.

12 Reason JT, Carthey J, de Leval MR. Diagnosing 'vulnerable system syndrome': an essential prerequisite to effective risk management. Qual Health Care 2001; 10 (Suppl. II): ii21–5.

13 Aronson JK. Medication errors resulting from the confusion of drug names. Expert Opin Drug Saf 2004; 3: 167–72.

14 Nolan TW. System changes to improve patient safety. BMJ 2000; 320: 771–3.

15 Spinewine A, Schmader KE, Barber N, Hughes C, Lapane KL, Swine C, Hanlon JT. Appropriate prescribing in elderly people: how well can it be measured and optimised? Lancet 2007; 370: 173–84.

16 Thomsen LA, Winterstein AG, Søndergaard B, Haugbølle LS, Melander A. Systematic review of the incidence and characteristics of preventable adverse drug events in ambulatory care. Ann Pharmacother 2007; 41: 1411–26.

17 Dean B. Learning from prescribing errors. Qual Saf Health Care 2002; 11: 258–60.

18 Leape LL. Reporting of adverse events. N Engl J Med 2002; 347: 1633–8.

19 Kaldjian LC, Jones EW, Wu BJ, Forman-Hoffman VL, Levi BH, Rosenthal GE. Reporting medical errors to improve patient safety: a survey of physicians in teaching hospitals. Arch Intern Med 2008; 168: 40–6.

20 Jha AK, Kuperman GJ, Teich JM, Leape L, Shea B, Rittenberg E, Burdick E, Seger DL, Vander Vliet M, Bates DW. Identifying adverse drug events: development of a computer-based monitor and comparison with chart review and stimulated voluntary report. J Am Med Inform Assoc 1998; 5: 305–14.

21 Pollock M, Bazaldua OV, Dobbie AE. Appropriate prescribing of medications: an eight-step approach. Am Fam Physician 2007; 75: 231–6, 239–40.

22 Glasziou P, Irwig L, Aronson JK, eds. Evidence-based Medical Monitoring: From Principles to Practice. Oxford: Wiley-Blackwell, 2008.

23 Durieux P, Trinquart L, Colombet I, Niès J, Walton R, Rajeswaran A, Rège Walther M, Harvey E, Burnand B. Computerized advice on drug dosage to improve prescribing practice. Cochrane Database Syst Rev 2008; (3): CD002894.

24 Gommans J, McIntosh P, Bee S, Allan W. Improving the quality of written prescriptions in a general hospital: the influence of 10 years of serial audits and targeted interventions. Intern Med J 2008; 38: 243–8.

25 Leape LL, Cullen DJ, Clapp MD, Burdick E, Demonaco HJ, Erickson JI, Bates DW. Pharmacist participation on physician rounds and adverse drug events in the intensive care unit. JAMA 1999; 282: 267–70.

26 Holland R, Desborough J, Goodyear L, Hall S, Wright D, Loke YK. Does pharmacist-led medication review help to reduce hospital admission and death in older people? A systematic review and meta-analysis. Br J Clin Pharmacol 2007; 65: 303–16.

27 Aronson JK, Henderson G, Webb DJ, Rawlins MD. A prescription for better prescribing. BMJ 2006; 333: 459–60.

28 Aronson JK. A prescription for better prescribing. Br J Clin Pharmacol 2006; 61: 487–91.

29 Thomas AN, Boxall EM, Laha SK, Day AJ, Grundy D. An educational and audit tool to reduce prescribing error in intensive care. Qual Saf Health Care 2008; 17: 360–3.